CERTIFICATION OF TRANSLATION

I, ***Sohee Kim***, an employee of Y.P.LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statement in the English language in the attached translation of ***Korean Patent Application No. 10-2002-0076221*** consisting of 30 pages, have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 13th day of February 2007

Sohee Kim

ABSTRACT

[Abstract of the Disclosure]

Provide are an apparatus and method for reproducing information from an optical information storage medium in which its inherent information and control data is recorded according to a bi-phase modulation method and other data is recorded according to a general modulation method. The optical information reproducing apparatus includes a light source, a photodetector including first and second photodiodes, a data demodulator that demodulates reproduction-related user data from a sum signal of signals detected by the first and second photodiodes, and a read only memory-permanent information & control data (ROM-PIC) demodulator that demodulates optical information storage medium-related information from the sum signal. The optical information reproducing apparatus includes a data demodulator that demodulates reproduction-related user data from the sum signal, a read only memory-permanent information & control data (ROM-PIC) demodulator that demodulates read-only optical information storage medium-related information from the sum signal, a wobble PIC demodulator that demodulates recordable optical information storage medium-related information that is recorded as pit wobbles, from a differential signal, and a wobble physical identification data (PID) demodulator that demodulates physical identification data that is recorded as pit wobbles on the recordable optical information storage medium, from the differential signal.

[Representative Drawing]

FIG. 6

SPECIFICATION

[Title of the Invention]

Optical information reproducing apparatus and method

[Brief Description of the Drawings]

FIG. 1 schematically illustrates the entire structure of a conventional optical information storage medium;

FIG. 2 schematically shows an optical arrangement of an optical head unit used for an optical information reproducing apparatus;

FIG. 3 schematically shows a photodetector shown in FIG. 2;

FIG. 4 schematically shows a demodulator unit used for a general read-only optical information storage medium;

FIG. 5 schematically illustrates the entire structure of a read-only optical information storage medium;

FIG. 6 shows a demodulator unit for an optical information reproducing apparatus according to an embodiment of the present invention;

FIG. 7 shows a demodulator unit used for a general recordable optical information storage medium; and

FIG. 8 shows a demodulator unit for an optical information reproducing apparatus according to another embodiment of the present invention.

< Explanation of Reference numerals designating the Major Elements of the Drawings >

21... light source	23... collimating lens
25... beam splitter	27... objective lens
30... photodetector	31... first photodiode
35... second photodiode	50... optical information storage medium
51... lead-in area	53... data area
55... lead-out area	57... permanent information & control (PIC) area
59... reproduction-related area	61, 81... data demodulator
63, 83... ROM-PIC demodulator	65... modulation code detector

67, 89... signal processor   85... wobble PIC demodulator
87... wobble PID demodulator

[Detailed Description of the Invention]
[Object of the Invention]
[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to an apparatus and method for reproducing information from an optical information storage medium, and more particularly, to an apparatus and method for reproducing information from an optical information storage medium in which its inherent information and control data is recorded according to a bi-phase modulation method and other data is recorded according to a general modulation method.

Optical discs are generally used as information storage media of optical pickup devices which record information on and/or reproduce information from the optical discs in a non-contact manner. Optical discs are classified as either compact discs (CDs) or digital versatile discs (DVDs) according to their information recording capacity. CDs and DVDs further include 650MB CD-Rs, CD-RWs, 4.7GB DVD+RWs, DVD-random access memories (DVD-RAMs), DVD-R/rewritables (DVD-RWs), and so forth. Read-only discs include 650MB CDs, 4.7GB DVD-ROMs, and the like. Furthermore, high-density digital versatile discs (HD-DVD) having a recording capacity of 23GB or more have been developed.

The above-mentioned optical information media are standardized according to their types so as to be compatibly used in different reproducing devices. Thus, users can conveniently use the optical information media and cost for purchasing the optical information media can be saved.

General optical information storage media use a method of recording data as pits or groove wobbles. Here, pits are miniature scratches that are physically formed in a substrate when manufacturing a disc, and groove wobbles are grooves that are formed in the waveform. Also, a pit signal is detected as a jitter value while a groove wobble signal is detected as a push-pull signal.

Referring to FIG. 1, a conventional HD-rewritable (HD-RW) optical storage medium 10 includes a data area 13 in which user data is recorded, a lead-in area 11 which is formed inside the data area 13, and a lead-out area 15 which is formed outside

the data area 13. Here, a storage medium-related information area 17 is prepared in the entire lead-in area 11 or a portion of the lead-in area 11, and read-only data such as storage medium-related information and the like is recorded in the storage medium-related information area 17. The read-only data is recorded in a relatively high frequency wobble form. Data is recorded in a relatively low frequency wobble form in a recordable area 19 in which the user data is recorded in grooves. The recordable area 19 is formed in the portion of the lead-in area 11, the data area 13, and the lead-out area 15. If the optical information storage media is formed in a multi-layer structure, the entire surface of the HD-RW storage medium 10 is formed in a groove form to remove a difference between an amount of transmitted light and an amount of reflected light due to a diffraction effect in a groove region and a pit region.

A HD-read only memory (HD-ROM), which complies with the same physical format such as a modulation method, a minimum pit length, a track pitch, or the like, contains user data such as contents in advance recorded when a substrate is manufactured. Thus, it is preferable that the storage medium-related information is recorded as pits instead of groove wobbles in the storage medium-related area 17 corresponding to the portion of the lead-in area 11 when the substrate is manufactured.

In consideration of the above-described problems, the present applicant suggested "Optical Information Storage Medium and Recording and/or Reproducing Method Therefor" in Korean Patent Application No. 10-2002-0053953, filed on September 6, 2002.

The suggested invention is concerned with a read-only storage medium, such as a read-only HD-digital versatile disc (HD-DVD), in which storage medium-related information is recorded as pit wobbles in the entire lead-in area or a portion of the lead-in area and data is recorded as pits in the remaining area, i.e., a user data area.

In order to increase the reliability of data, on the read-only storage medium, storage medium-related information data is recorded using a pattern different from a sync signal recorded in a user data area and user data is recorded using a specific pattern. Also, a modulation method that is different from the user data is used.

A data recording modulation method used in the entire lead-in area or a portion of the lead-in area and a data recording modulation method used in the remaining area are the same as that of a recordable optical information storage medium. In other words, a bi-phase modulation method is used in an area in which inherent information of

the storage medium and control data is recorded and data is recorded in the remaining area using a general modulation method.

Data is recorded as pits everywhere on the optical information storage medium having the above-described structure. Thus, a process of manufacturing the optical information storage medium can be simplified and pits can be formed to a depth from which an optimum signal is output without considering a difference between the characteristics of signals due to groove wobbles and pits. As a result, the optical information storage medium can improve recording and/or reproduction characteristics. Also, the suggested optical information storage medium uses the same data recording modulation method as the recordable optical information storage medium so as to maintain consistency with other types of optical information storage media.

Meanwhile, the suggested invention discloses only the read-only high-density optical information storage medium not an apparatus and method for recording information on and/or reproducing information from both the read-only optical information storage medium and the recordable optical information storage medium.

[Technical Goal of the Invention]

The present invention provides an apparatus and method for reproducing optical information recorded on an optical information storage medium and a recordable optical information storage medium having new formats suggested by the present applicant.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided an optical information reproducing apparatus for reproducing information from an optical information storage medium which includes a lead-in area, a user data area, and a lead-out area, whereon optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the optical information storage medium. The optical information reproducing apparatus includes: a light source that radiates a laser light beam; an objective lens that condenses the laser light beam to be focused on the optical information storage medium; a photodetector that receives the laser light beam reflected from the optical information storage medium and that comprises first and second photodiodes which independently convert a received

optical signal into an electric signal; a data demodulator that demodulates the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes; and a read only memory-permanent information & control data (ROM-PIC) demodulator that demodulates the optical information storage medium-related information from the sum signal.

According to another aspect of the present invention, there is provided an optical information reproducing apparatus for recording information on and/or reproducing information from a read-only optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon read-only optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the read-only optical information storage medium, or recording information on and/or reproducing information from a recordable optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon recordable optical information storage medium-related information is recorded as pit wobbles in the entire lead-in area or a portion of the lead-in area and recording- and reproduction-related user data is recorded in a remaining area of the recordable optical information storage medium. The optical information reproducing apparatus includes: a light source that radiates a laser light beam; an objective lens that condenses the laser light beam to be focused on the read-only optical information storage medium or the recordable optical information storage medium; a photodetector that receives the laser light beam reflected from the read-only optical information storage medium or the recordable optical information storage medium and comprises first and second photodiodes that independently convert a received optical signal into an electric signal; a data demodulator that demodulates the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes; a read only memory-permanent information & control data (ROM-PIC) demodulator that demodulates the read-only optical information storage medium-related information from the sum signal; a wobble PIC demodulator that demodulates the recordable optical information storage medium-related information that is recorded as pit wobbles, from a differential signal of the signals detected by the first and second photodiodes; and a wobble physical identification data (PID) demodulator that demodulates physical identification data that is recorded as pit wobbles on the recordable optical information

storage medium, from the differential signal of the signals detected by the first and second photodiodes. The optical information reproducing apparatus reproduces information from the read-only optical information storage medium using signals obtained from the data demodulator and the ROM-PIC demodulator, while the optical information reproducing apparatus reproduces information from the recordable optical information storage medium using signals obtained from the data demodulator, the wobble PIC demodulator, and the wobble PID demodulator.

According to still another aspect of the present invention, there is provided an optical information reproducing method of reproducing information from an optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the optical information storage medium. The optical information reproducing method includes: radiating a laser light beam onto the optical information storage medium; receiving the laser light beam reflected from the optical information storage medium using a photodetector comprising first and second photodiodes that independently convert a received optical signal into an electric signal; demodulating the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes; and demodulating the optical information storage medium-related information from the sum signal.

According to yet another aspect of the present invention, there is provided an optical information reproducing method of recording information on and/or reproducing information from a read-only optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, where read-only optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the read-only optical information storage medium, or recording information on and/or reproducing information from a recordable optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon recordable optical information storage medium-related information is recorded as pit wobbles in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the recordable optical information storage medium. The optical information reproducing method includes: radiating a laser light beam;

receiving the laser light beam reflected from the read-only optical information storage medium or the recordable optical information storage medium using a photodetector comprising first and second photodiodes that independently convert a received optical signal into an electric signal; determining whether the read-only optical information storage medium or the recordable optical information storage medium is used depending on whether a differential signal of signals detected by the first and second photodiodes comprises a wobbling signal; demodulating the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes; demodulating the read-only optical information storage medium-related information from the sum signal using a ROM-PIC demodulator when the read-only optical information storage medium is used; and when the recordable optical information storage medium is used, demodulating the recordable optical information storage medium-related information that is recorded as pit wobbles, from the differential signal of the signals detected by the first and second photodiodes using a wobble PID demodulator and demodulating physical identification data that is recorded as pit wobbles on the recordable optical information storage medium, from the differential signal of the signals detected by the first and second photodiodes using a wobble PID demodulator.

Preferred embodiments of the present invention will now be described with reference to the attached drawings.

An optical information reproducing apparatus according to the present invention can include an optical head unit of FIGS 2 and 3, and a signal demodulator unit and a signal processor of FIGS. 6 and 8.

Referring to FIG. 2, the optical head unit includes a light source 21 which radiates a laser light beam, an objective lens 27 which condenses the laser light beam to form an optical spot on an optical information storage medium D, and a photodetector 30 which receives the laser light beam reflected from the optical information storage medium D.

Here, a beam splitter 25, which changes a path of incident light, is installed among the light source 21, and objective lens 27, and the photodetector 30. The beam splitter 25 transmits at least a portion of the laser light beam emitted from the light source 21 toward the optical information storage medium D and reflects at least a portion of the laser light beam reflected from the optical information storage medium D toward the photodetector 30. A collimating lens 23, which condenses a divergent light

beam radiated from the light source 21 to make the divergent light beam into a parallel light beam, is further included between the light source 21 and the beam splitter 25.

Referring to FIG. 3, the photodetector 30 includes first and second photodiodes 31 and 35 which independently convert a received optical signal into an electric signal. The first and second photodiodes 31 and 35 make a two-division structure so as to be symmetrical in a tangential direction as indicated by arrow A.

Here, when the first and second photodiodes 31 and 35 receive signals P_1 and P_2, respectively, a sum signal CH_1 and a differential signal CH_2 can be defined as in Equation 1:

$$CH_1 = P_1 + P_2$$
$$CH_2 = P_1 - P_2 \qquad \text{...(1)}$$

When the optical information reproducing apparatus according to the present invention reproduces signals from a read-only optical information storage medium and a recordable optical information storage medium using the optical head unit having the above-described structure, the optical information reproducing apparatus uses the first and second channels CH_1 and CH_2 in different ways. This will be explained below.

Prior to the description of a demodulator and a signal processor of the optical information reproducing apparatus according to the present invention, reproduction of information from a ROM disc (general read-only storage medium) on which a write signal is recorded as a pit will be explained.

In a case of the general read-only storage medium, data demodulating and signal processing are performed using only the sum signal output via the first channel CH_1. In other words, an additional structure is not needed to demodulate storage medium-related information recorded on the general read-only storage medium. Rather, as shown in FIG. 4, a data demodulator 41 demodulates a signal input via the first channel CH_1 and a signal processor 45 reproduces the demodulated signal. Accordingly, the optical information reproducing apparatus having the above-described structure cannot reproduce information from an optical information storage medium on which inherent information on the storage medium and control data is recorded according to a bi-phase modulation method and other data is recorded according to a general modulation method.

According to an aspect of the present invention, the optical information reproducing apparatus reproduces information from a read-only optical information storage medium 50 having a structure as shown in FIG. 5 and includes the previously described optical head unit, and a data demodulator 61, a ROM-permanent information & control data (PIC) demodulator 63, and a signal processor 67 as shown in FIG. 6.

Referring to FIG. 5, the read-only optical information storage medium 50 includes a lead-in area 51, a user data area 53, and a lead-out area 55. Here, a PIC area 57 in which PIC is recorded as pit wobbles is formed in the entire lead-in area 51 or a portion of the lead-in area 51. A reproduction-related area 59 in which user data is recorded as general pits is formed in the remaining area of the read-only optical information storage medium 50. The pit wobble refers to a sequence of pits arranged in a waveform, and the general pits refer to pits arranged in a line.

Data is recorded as pits in both the PIC area 57 and the reproduction-related area 59 using different modulation codes. In other words, the PIC is recorded in the entire lead-in area 51 or the portion of the lead-in area 51 according to the bi-phase modulation method and reproduction-related data is recorded in the user data area 53 according to a run length-limited (RLL) modulation method.

The RLL modulation method indicates how many successive zeros exist between "1" bits. Thus, RLL (d, k) represents that a minimum number and a maximum number of successive zeros between "1" bits are "d" and "k", respectively. The bi-phase modulation method is a method of recording data depending on whether a predetermined signal varies within a predetermined period. For example, when the phase of a groove wobble does not change within a predetermined period, data bits of value "0" are recorded. In contrast, when the phase of the groove wobble changes within the predetermined period, data bits of value "1" are recorded.

Referring to FIG. 6, the data demodulator 61 and the ROM-PIC demodulator 63 demodulate the reproduction-related user data and the PIC input via the first channel CH_1, respectively. Here, the data demodulator 61 reproduces the reproduction-related user data that is recorded on the read-only optical information storage medium 50 according to the RLL modulation method. The ROM-PIC demodulator 63 reproduces the PIC that is recorded on the read-only optical information storage medium 50 according to the bi-phase modulation method.

The data demodulator 61 may reproduce information from the read-only optical information storage medium 50 using a RLL (1, 7) modulation method. In the RLL (1, 7) modulation method, a minimum number and a maximum number of successive zeros existing between "1" bits are 1 and 7, respectively. According to the RLL (1, 7) modulation method, when d=1, data of "1010101" is recorded and thus the length of a mark or a space between two bits of value "1" is 2T. Also, when d=7, data of "1000000010000001" is recorded and thus the length of a mark or a space between two bits of value "1" is 8T. Thus, in the RLL (1, 7) modulation method, data is recorded as marks and spaces of length 2T, and marks and spaces of length 8T.

Here, 9T that is not used in the RLL (1, 7) modulation method may be used as a sync pattern. When 6T is determined as a basic period and a signal does not change within the basic period of 6T, data bits of value "0" are recorded. When a signal changes within a period of a pit of length 3T and a space of length 3T, data bits of value "1" are recorded.

The data demodulator 61 may reproduce information from the read-only optical information storage medium 50 using an RLL (2, 10) modulation method. According to the RLL (2, 10) modulation method, data is recorded as pits and spaces with lengths between 3T and 11T.

Data recorded according to the bi-phase modulation method is composed of a mark and a space having a length of nT, and a mark and a space having a length of 2nT, wherein **n** is an integer between 2 and 8. For example, if n=2, data recorded according to the bi-phase modulation method is composed of marks and spaces having a length of 2T, and marks and spaces having a length of 4T. If n=8, data recorded according to the bi-phase modulation method is composed of marks and spaces having a length of 8T, and marks and spaces having a length of 16T. The bi-phase modulation method uses only 3T/6T/9T. Thus, since the PIC area 57 corresponds to an area in which 3T/6T/9T are concentratedly detected, the PIC area 57 can be distinguished from the reproduction-related data area 59.

In order to check whether the read-only optical information storage medium 50 uses the different modulation codes as described above, the optical information reproducing apparatus according to the present invention preferably further includes a modulation code detector 65 which detects a modulation code from the sum signal S input via the first channel CH_1.

The modulation code detector 65 can detect the marks and spaces having a length of nT, and the marks and spaces having a length of 2nT recorded according to the bi-phase modulation method to check whether the read-only optical information storage medium 50 include a plurality of different modulation codes.

In a case where a read-only optical disc is used as the read-only optical information storage medium 50, a lead-in area or a specific area may use a different modulation code from a user data area, which may affect a servo characteristic. Due to this, if the magnitudes of a focus error signal and a track error signal detected by the photodetector (30 of FIG. 2) are different from that of a data signal, the optical information reproducing apparatus may further include an adjuster circuit capable of adjusting the focus error signal and the track error signal.

For example, in an event that the lead-in area or the specific area uses a bi-phase modulation code, an average channel bit length of the read-only optical disc gets longer than when an RLL (1, 7) modulation code is used in the data area. This affects an amount of light reflected from the read-only optical disc. As a result, the magnitude of the focus error signal or the track error signal detected from the lead-in area or the specific area becomes different from the magnitude of the data signal detected from the data area. Therefore, by further installing the adjuster circuit, the servo characteristic can be improved when a track pitch in the lead-in area or the specific area is different from that in the data area or a reflectivity varies depending on a modulation code.

Accordingly, the optical information reproducing apparatus having the above-described structure can reproduce information from the optical information storage medium having a new format suggested by the present applicant, i.e., from an optical information storage medium in which inherent information on the storage medium and control data is recorded according to the bi-phase modulation method and other data is recorded according to the general modulation method, and a recordable optical information storage medium.

A method of reproducing optical information from the read-only optical information storage medium 50 in which data is recorded as pits in both the PIC area 57 and the reproduction-related area 59 will not be explained.

Referring to FIGS. 2 and 3, the light source 21 radiates a laser light beam onto the read-only optical information storage medium 50. The objective lens 27 condenses

the radiated laser light beam to be focused onto the read-only optical information storage medium 50. The photodetector 30 receives the laser light beam reflected from the read-only optical information storage medium 50 via the beam splitter 25. Referring to FIG. 6, the data demodulator 61 demodulates the reproduction-related user data signal from the sum signal S of signals detected by the first and second photodiodes 31 and 35, i.e., the signal input via the first channel CH_1. The ROM-PIC demodulator 63 demodulates the PIC from the signal input via the first channel CH_1.

Here, on the read-only optical information storage medium 50, the reproduction-related user data is recorded according to the RLL modulation method and the PIC is recorded according to the bi-phase modulation method. As described above, it is preferable that the RLL modulation method is the RLL (1, 7) modulation method or the RLL (2, 10) modulation method.

Information is recorded as marks and spaces having a length of nT, and marks and spaces having a length of 2nT on the read-only optical information storage medium 50 according to the bi-phase modulation method, wherein **n** is an integer within a range of 2 – 8.

It is preferable that the optical information reproducing method according to the present embodiment further includes detecting from the signal input via the first channel CH_1 whether the read-only optical information storage medium 50 includes a plurality of different modulation codes, using the modulation code detector 65. This modulation code detecting method detects whether the read-only optical information storage medium 50 includes what types of modulation codes by detecting the mark and the space having a length of nT, and the mark and the space having a length of 2nT recorded according to the bi-phase modulation method.

The above-described optical information reproducing method can be applied to an optical information storage medium having two or more information layers as well as to an optical information storage medium having a single information layer.

When the optical information reproducing apparatus reproduces a signal from the read-only information storage medium via the optical head unit described with reference to FIGS. 2 and 3, the optical information reproducing apparatus uses only the first channel CH_1. However, when the optical information reproducing apparatus reproduces a signal from the recordable optical information storage medium via the

optical head unit, the optical information reproducing apparatus uses both the first and second channels CH_1 and CH_2.

In other words, guides with land and groove forms for tracking are formed on a recordable optical information storage medium, e.g., a recordable (R) disc or a rewritable (RW) disc, and the lands and/or grooves wobble in order to record information indicating the position of the recordable optical information storage medium. Thus, besides a data demodulator demodulating the sum signal output via the first channel CH_1, an additional demodulator is required to demodulate the wobbling signal using the differential signal output via the second channel CH_2.

Before the demodulator and the signal processor of the optical information reproducing apparatus according to the present invention are described, a method of reproducing information using a general optical information reproducing apparatus will be explained.

Referring to FIG. 7, on the read-only optical information storage medium, the general optical information reproducing apparatus demodulates and processes data using only the sum signal S output via the first channel CH_1. In other words, the general optical information reproducing apparatus requires an additional structure to demodulate the PIC, demodulates the sum signal S input via the first channel CH_1 using a data demodulator 71, and reproduces the sum signal S using a signal processor 77. When the general optical information reproducing apparatus performs reproduction from the recordable optical information storage medium, the general optical information reproducing apparatus uses both the first and second channels CH_1 and CH_2.

Accordingly, the general optical information reproducing apparatus includes the data demodulator 71 which demodulates data from the sum signal S input via the first channel CH_1, a wobble PIC demodulator 73 which demodulates a wobble PIC signal from the differential signal D input via the second channel CH_2, and a wobble physical identification data (PID) demodulator 75 which demodulates a PID signal from the differential signal D input via the second channel CH_2. The signal processor 77 reproduces the signals demodulated by the data demodulator 71, the wobble PIC demodulator 73, and the wobble PID demodulator 75.

Reproduction from the recordable optical information storage medium using the general optical information reproducing apparatus having the above-described structure is performed without any problem. However, the general optical information

reproducing apparatus cannot reproduce information from the read-only optical information storage medium on which its inherent information and control data is recorded according to the bi-phase demodulation method and other data is recorded according to the general demodulation method.

The optical information reproducing apparatus according to the present invention is characterized by an improved structure so as to reproduce information from a general recordable optical information storage medium as well as from the optical information storage medium having new formats suggested by the present applicant.

The optical information reproducing apparatus according to the present invention may include the optical head unit described with reference to FIG. 2, a demodulator unit, and a signal processor 89 illustrated as in FIG. 8.

Referring to FIG. 8, the demodulator unit includes a data demodulator 81 which demodulates the sum signal S input via the first channel CH_1, a ROM-PIC demodulator 83 which demodulates PIC, a wobble PIC demodulator 85 which demodulates the differential signal D input via the second channel CH_2, and a wobble PID demodulator 87. The demodulating unit having the above-described structure is connected to the signal processor 89.

The data demodulator 81 and the ROM-PIC demodulator 83 demodulate reproduction-related user data and the PIC, respectively, input via the first channel CH_1. The data demodulator 81 reproduces the reproduction-related user data recorded on the optical information storage medium according to the RLL modulation method. Here, the optical information storage medium may be the read-only optical information storage medium or the recordable optical information storage medium. The ROM-PIC demodulator 83 reproduces the PIC recorded on the read-only optical information storage medium 50 of FIG. 5 according to the bi-phase modulation method.

Here, the recordable optical information storage medium includes a lead-in area in which a wobble PIC area is formed to pre-record manufacturing-related information. The manufacturing-related information recorded in the wobble PIC area is modulated according to a different modulation method from a data area. The wobble PIC demodulator 85 and the wobble PID demodulator 87 are used when demodulating data from the recordable optical information storage medium, and are responsible for demodulation in the PIC area and the data area, respectively.

As described above, the demodulating unit is connected to the signal processor 89. However, this connection is according to the type of used optical information storage medium.

In other words, the demodulating unit includes a switch SW_1 to selectively connect the ROM-PIC demodulator 83 and the wobble PID demodulator 85 to the signal processor 89 according to the type of used optical information storage medium. The demodulating unit also includes a switch SW_2 to selectively connect the wobble PID demodulator 87 to the signal processor 89.

During reproduction from the read-only optical information storage medium, the switch SW_1 is connected with a node T_1 to connect the ROM-PIC demodulator 83 to the signal processor 89, while the switch SW_2 is opened. Accordingly, when the optical head unit shown in FIG. 2 forms an optical spot in the PIC area of the read-only optical information storage medium, the ROM-PIC demodulator 83 is used. When the optical spot is formed in the remaining area, the data demodulator 81 is used. Here, since data is recorded as different modulation codes in the PIC area and the remaining area, the PIC area can be discriminated from the remaining area. Thus, it is preferable that the demodulating unit include the modulation code detector 65 of FIG. 6 to detect from the sum signal S input via the first channel CH_1 whether the optical information storage medium includes a plurality of different modulation codes. This modulation code detecting method detects whether the optical information storage medium includes what types of modulation codes by detecting the mark and the space having a length of nT, and the mark and the space having a length of 2nT recorded according to the bi-phase modulation method.

The structure and operation of the optical information reproducing apparatus performing reproduction from the above-described read-only optical information storage medium are the same as those of the optical information storage medium described with reference to FIG. 6, and thus will not be described herein.

During reproduction from the recordable optical information storage medium, the switch SW_1 is connected with a node T_2 to connect the wobble PID demodulator 85 to the signal processor 89. Here, the switch SW_2 is also connected with a node T_3 to connect the wobble PID demodulator 87 to the signal processor 89. Thus, when the optical spot is located in the PIC area of the lead-in area, the wobble PIC demodulator 85 is used. When the optical spot is located in the remaining area, the wobble PID

demodulator 87 is used. Here, since data is recorded as different modulation codes in a wobble PIC area and a wobble PID area, the wobble PIC area can be distinguished from the PID area.

Whether an optical information storage medium is classified as the read-only optical information storage medium or the recordable optical information storage medium is determined depending on whether a wobbling signal is input via the second channel CH_2. When the wobbling signal is not input via the second channel CH_2, the used optical information storage medium is classified as the read-only optical information storage medium. Thus, information can be reproduced using only a signal input via the first channel CH_1. When the wobbling signal is input via the second channel CH_2, the used optical information storage medium is classified as the recordable information storage medium. Thus, information can be reproduced using signals input via the first and second channels CH_1 and CH_2.

A method of reproducing information recorded on the read-only optical information storage medium and the recordable optical information storage medium will be described.

Here, the method of reproducing information from the read-only optical information storage medium has been described with reference to FIG. 5 and thus will not be explained herein. The recordable optical information storage medium includes a lead-in area, a user data area, and a lead-out area. Storage medium-related information is recorded as pit wobbles in the entire lead-in area or a portion of the lead-in area and recording- and reproduction-related user data is recorded in the remaining area of the recordable optical information storage medium.

Referring to FIGS. 2 and 3, the light source 21 radiates a laser light beam onto the read-only optical information storage medium 50. The objective lens 27 condenses the radiated laser light beam to be focused onto the read-only optical information storage medium 50. The photodetector 30 receives the laser light beam reflected from the read-only optical information storage medium 50 via the beam splitter 25.

Referring to FIG. 8, the optical information reproducing method includes determining the type of used optical information storage medium depending on whether the wobbling signal is input via the second channel CH_2.

If the wobbling signal is not input via the second channel CH_2, the used optical information storage medium is classified as the read-only optical information storage

medium, a data signal input via the first channel CH_1 is demodulated using the data demodulator 81, and PIC input via the first channel CH_1 is demodulated using the ROM-PIC demodulator 83.

When the wobbling signal is input via the second channel CH_2, recordable optical information storage medium-related information recorded as pit wobbles are demodulated from the differential signal D input via the second channel CH_2 using the wobble PIC demodulator 85. PID recorded as pit wobbles on the recordable optical information storage medium is demodulated from the differential signal D using the wobble PID demodulator 87. Here, modulation codes of the optical information storage medium are the same as those described with reference to FIGS. 5 and 6 and thus will not be described herein.

The optical information reproducing method according to the present embodiment preferably includes detecting from the signal input via the first channel CH_1 whether the optical information storage medium has a plurality of different modulation codes, using the modulation code detector 65 of FIG. 6. This modulation code detecting method detects whether the optical information storage medium includes what types of modulation codes by detecting the mark and the space having a length of nT, and the mark and the space having a length of 2nT recorded according to the bi-phase modulation method.

The above-described optical information reproducing method according to the present invention can be used for an optical information storage medium having two or more information layers as well as for an optical information storage medium having a single information layer.

[Effect of the Invention]

As described above, an optical information reproducing apparatus and method according to the present invention can reproduce information from a read-only optical information storage medium in which storage medium-related information data is recorded as pit wobbles in the entire lead-in area or a portion of the lead-in area and data is recorded as general pits in the remaining area, i.e., in a user data area and a recordable optical information storage medium.

What is claimed is:

1. An optical information reproducing apparatus for reproducing information from an optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the optical information storage medium, the optical information reproducing apparatus comprising:

a light source that radiates a laser light beam;

an objective lens that condenses the laser light beam to be focused on the optical information storage medium;

a photodetector that receives the laser light beam reflected from the optical information storage medium and that comprises first and second photodiodes which independently convert a received optical signal into an electric signal;

a data demodulator that demodulates the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes; and

a read only memory-permanent information & control data (ROM-PIC) demodulator that demodulates the optical information storage medium-related information from the sum signal.

2. An optical information reproducing apparatus for recording information on and/or reproducing information from a read-only optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon read-only optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the read-only optical information storage medium, or recording information on and/or reproducing information from a recordable optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon recordable optical information storage medium-related information is recorded as pit wobbles in the entire lead-in area or a portion of the lead-in area and recording- and reproduction-related user data is recorded in a remaining area of the recordable optical information storage medium, the optical information reproducing apparatus comprising:

a light source that radiates a laser light beam;

an objective lens that condenses the laser light beam to be focused on the read-only optical information storage medium or the recordable optical information storage medium;

a photodetector that receives the laser light beam reflected from the read-only optical information storage medium or the recordable optical information storage medium and comprises first and second photodiodes that independently convert a received optical signal into an electric signal;

a data demodulator that demodulates the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes; and

a read only memory-permanent information & control data (ROM-PIC) demodulator that demodulates the read-only optical information storage medium-related information from the sum signal;

a wobble PIC demodulator that demodulates the recordable optical information storage medium-related information that is recorded as pit wobbles, from a differential signal of the signals detected by the first and second photodiodes; and

a wobble physical identification data (PID) demodulator that demodulates physical identification data that is recorded as pit wobbles on the recordable optical information storage medium, from the differential signal of the signals detected by the first and second photodiodes,

wherein the optical information reproducing apparatus reproduces information from the read-only optical information storage medium using signals obtained from the data demodulator and the ROM-PIC demodulator, while the optical information reproducing apparatus reproduces information from the recordable optical information storage medium using signals obtained from the data demodulator, the wobble PIC demodulator, and the wobble PID demodulator.

3. The optical information reproducing apparatus of any one of claims 1 and 2, wherein the data demodulator reproduces the reproduction-related user data that is recorded on the optical information storage medium according to a run length-limited (RLL) modulation method, and the ROM-PIC demodulator reproduces the optical information storage medium-related information that is recorded on the optical information storage medium according to a bi-phase modulation method.

4. The optical information reproducing apparatus of claim 3, wherein the RLL modulation method is an RLL (1, 7) modulation method.

5. The optical information reproducing apparatus of claim 3, wherein the RLL modulation method is an RLL (2, 10) modulation method.

6. The optical information reproducing apparatus of any one of claims 3 through 5, wherein information is recorded as a mark and a space having a length of nT, and a mark and a space having a length of 2nT according to the bi-phase modulation method, where **n** is an integer between 2 and 8.

7. The optical information reproducing apparatus of claim 6, further comprising a modulation code detector that detects from the sum signal of the signals detected by the first and second photodiodes whether the optical information storage medium comprises a plurality of different modulation codes by detecting the mark and the space having a length of nT, and the mark and the space having a length of 2nT recorded according to the bi-phase modulation method.

8. The optical information reproducing apparatus of any one of claims 1 and 2, further comprising a modulation code detector that detects from the sum signal of the signals detected by the first and second photodiodes whether the optical information storage medium comprises a plurality of different modulation codes.

9. An optical information reproducing method of reproducing information from an optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the optical information storage medium, the optical information reproducing method comprising:

radiating a laser light beam onto the optical information storage medium;

receiving the laser light beam reflected from the optical information storage medium using a photodetector comprising first and second photodiodes that independently convert a received optical signal into an electric signal;

demodulating the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes; and

demodulating the optical information storage medium-related information from the sum signal.

10. An optical information reproducing method of recording information on and/or reproducing information from a read-only optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, where read-only optical information storage medium-related information is recorded in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the read-only optical information storage medium, or recording information on and/or reproducing information from a recordable optical information storage medium which comprises a lead-in area, a user data area, and a lead-out area, whereon recordable optical information storage medium-related information is recorded as pit wobbles in the entire lead-in area or a portion of the lead-in area and reproduction-related user data is recorded in a remaining area of the recordable optical information storage medium, the optical information reproducing method comprising:

radiating a laser light beam;

receiving the laser light beam reflected from the read-only optical information storage medium or the recordable optical information storage medium using a photodetector comprising first and second photodiodes that independently convert a received optical signal into an electric signal;

determining whether the read-only optical information storage medium or the recordable optical information storage medium is used depending on whether a differential signal of signals detected by the first and second photodiodes comprises a wobbling signal;

demodulating the reproduction-related user data from a sum signal of signals detected by the first and second photodiodes;

demodulating the read-only optical information storage medium-related information from the sum signal using a ROM-PIC demodulator when the read-only optical information storage medium is used; and

when the recordable optical information storage medium is used, demodulating the recordable optical information storage medium-related information that is recorded

as pit wobbles, from the differential signal of the signals detected by the first and second photodiodes using a wobble PID demodulator and demodulating physical identification data that is recorded as pit wobbles on the recordable optical information storage medium, from the differential signal of the signals detected by the first and second photodiodes using a wobble PID demodulator.

11. The optical information reproducing method of any one of claims 9 and 10, where the reproduction-related user data recorded according to an RLL modulation method on the optical information storage medium is reproduced in the demodulation of the reproduction-related user data, and the optical information storage medium-related information recorded on the optical information storage medium according to a bi-phase modulation method is reproduced in the demodulation of the optical information storage medium-related information.

12. The optical information reproducing method of claim 11, wherein the RLL modulation method is an RLL (1, 7) modulation method.

13. The optical information reproducing method of claim 11, wherein the RLL modulation method is an RLL (2, 10) modulation method.

14. The optical information reproducing method of any one of claims 11 through 13, wherein information is recorded as a mark and a space having a length of nT, and a mark and a space having a length of 2nT according to the bi-phase modulation method, where n is an integer between 2 and 8.

15. The optical information reproducing method of claim 14, further comprising a modulation code detector that detects from the sum signal of the signals detected by the first and second photodiodes whether the optical information storage medium comprises a plurality of different modulation codes by detecting the mark and the space having a length of nT, and the mark and the space having a length of 2nT recorded according to the bi-phase modulation method.

16. The optical information reproducing method of any one of claims 9 and 10, further comprising a modulation code detector that detects from the sum signal of the signals detected by the first and second photodiodes whether the optical information storage medium comprises a plurality of different modulation codes.

FIG. 1 (PRIOR ART)

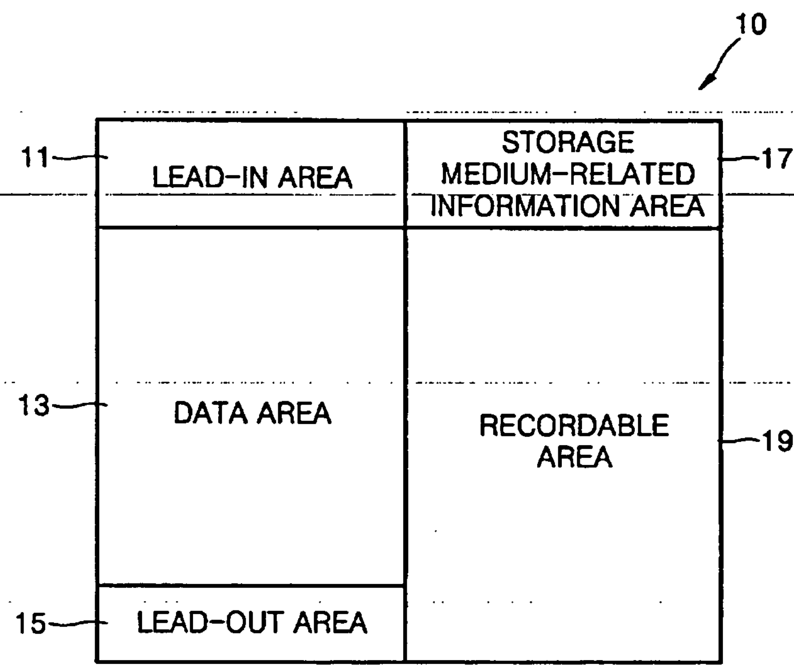


FIG. 2

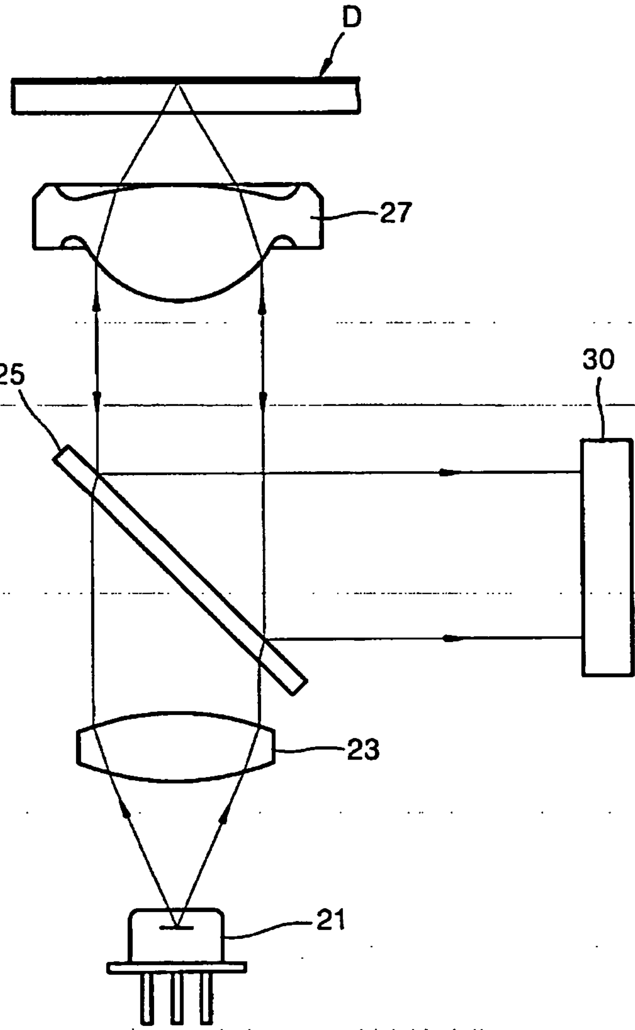


FIG. 3

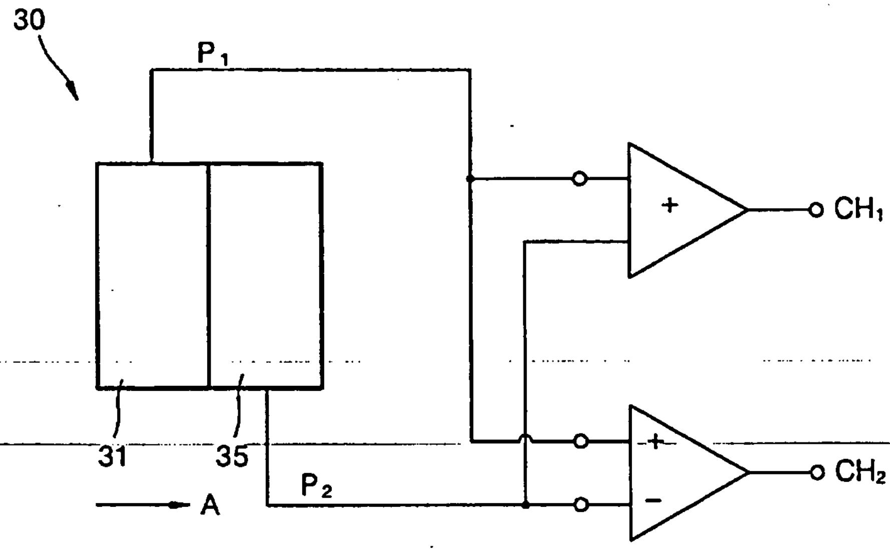

30
P_1
CH1
31
35
P_2
A
CH2
+
+
−

FIG. 4

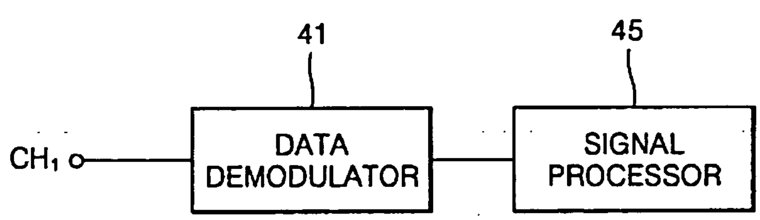

41
45
CH1
DATA DEMODULATOR
SIGNAL PROCESSOR

FIG. 5

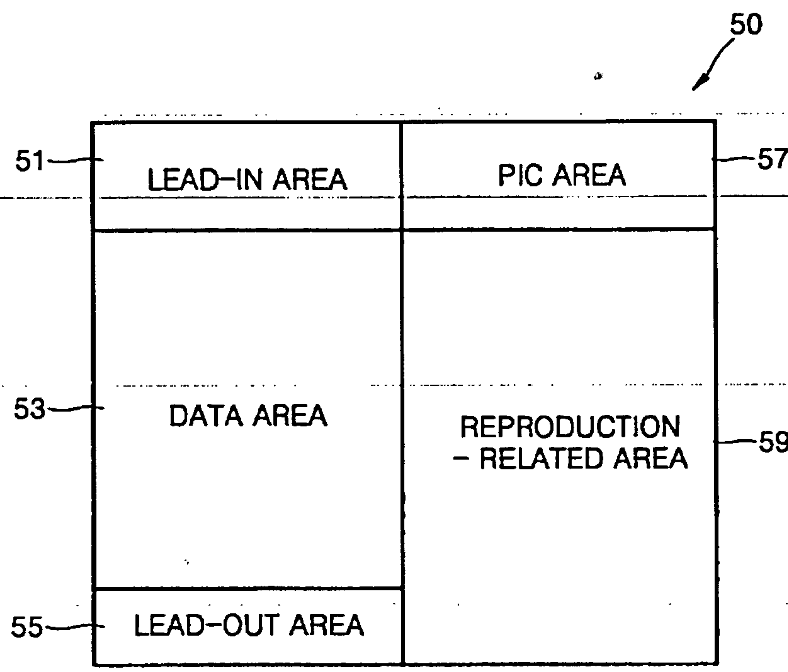
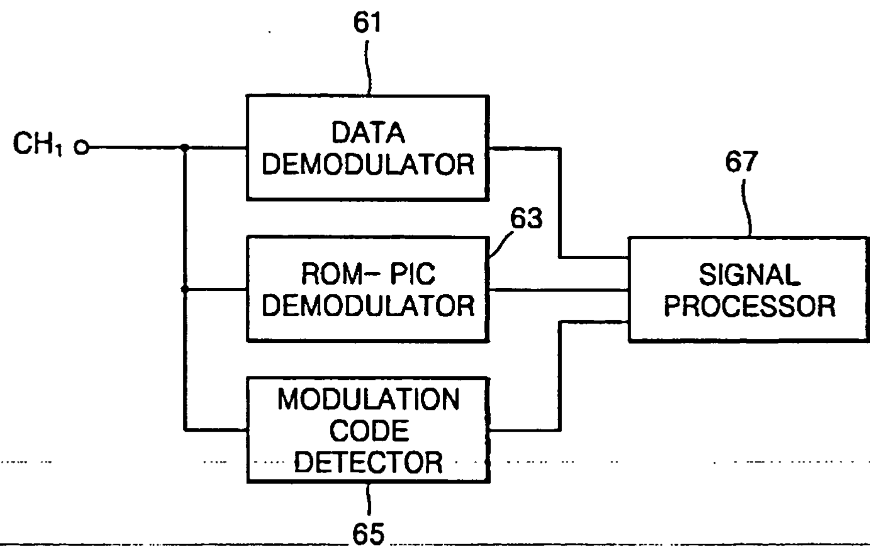
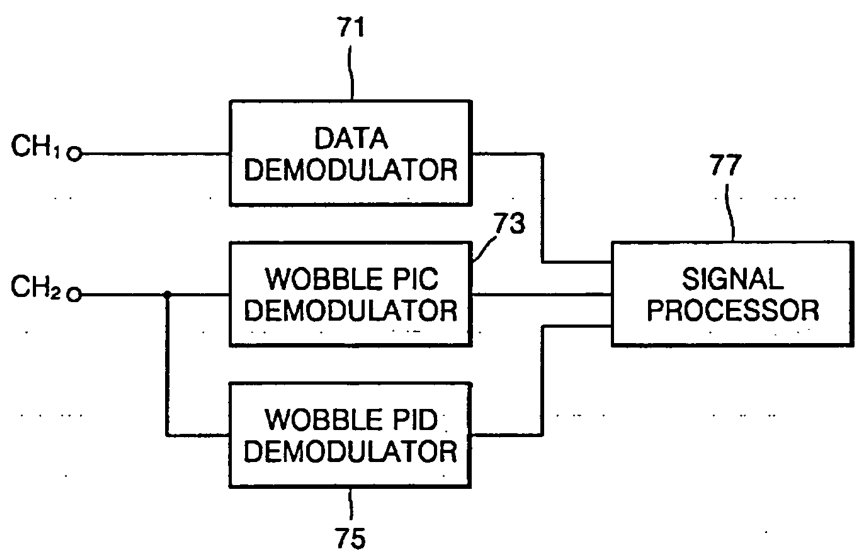

50
51
LEAD-IN AREA
PIC AREA
57
53
DATA AREA
REPRODUCTION
- RELATED AREA
59
55
LEAD-OUT AREA

FIG. 6



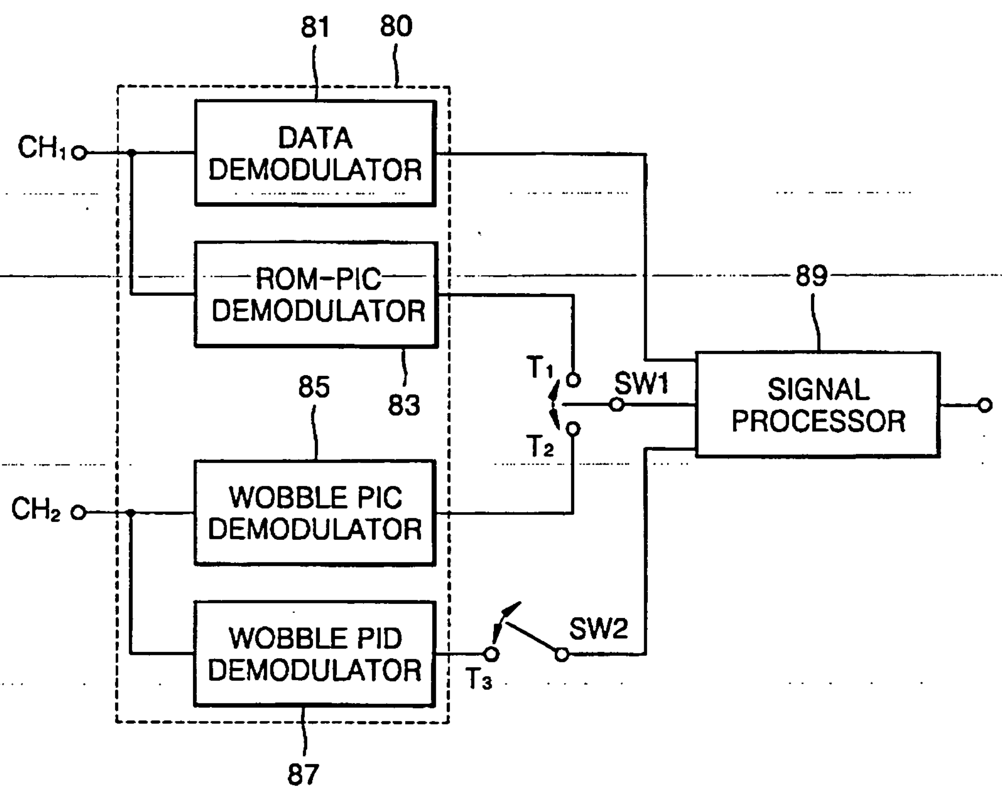
61
CH1
DATA DEMODULATOR
67
63
ROM- PIC DEMODULATOR
SIGNAL PROCESSOR
MODULATION CODE DETECTOR
65

FIG. 7



71
CH1
DATA DEMODULATOR
77
73
CH2
WOBBLE PIC DEMODULATOR
SIGNAL PROCESSOR
WOBBLE PID DEMODULATOR
75

FIG. 8



81
80
CH1
DATA DEMODULATOR
ROM-PIC DEMODULATOR
89
T1
SW1
SIGNAL PROCESSOR
85
83
T2
CH2
WOBBLE PIC DEMODULATOR
WOBBLE PID DEMODULATOR
SW2
T3
87

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